CLAIMS

What is claimed is:

1. A wear-resistant titanium device comprising:

a titanium device;

wear-resistance means for making the titanium device wear-resistant.

2. The device according to claim 1, wherein said device is an orthopedic device.

3. The device according to claim 2, wherein said orthopedic device is selected from the group consisting essentially of orthopedic implants, inner ear implants, dental implants and cardiovascular implants.

4. The device according to claim 3, wherein said orthopedic implants are selected from the group consisting essentially of spinal implants, hip implants, knee implants, shoulder, elbow, finger, toe, other joint implants, bone plates, fixation screws, intramedullary nails, compression hip screws, pelvic plates, and other orthopedic implants.

5. The device according to claim 1, wherein said titanium alloy is formed of titanium and a metal selected from the group consisting essentially of niobium, tin, zirconium, chromium, aluminum, molybdenum, vanadium, tantalum, silicon, and iron.

6. The device according to claim 5, wherein said titanium alloy is selected from the group consisting essentially of Ti-6Al-4V, Ti-13Nb-13Zr, Ti-12Mo-6Zr-2Fe, Ti-5Al-2.5Fe, Ti-3Al-2.5V, Ti-3Al-8V-6Cr-4Mo-4Zr, Ti-15Mo-3Al-2.7Nb-0.25Si, Ti-15Mo-2.8Nb-0.2Si Ti-6Al-4V ELI, Ti-6Al-7Nb, Ti-35Nb-7Zr-5Ta,

Ti-45Nb, Ti-18V-5Fe-1Al, Ti-15Mo-5Zr, Ti-11.5Mo-6Zr-4.5Sn, Ti-5Al-2Sn-4Zr-4Mo-2Cr-1Fe, and Ti-15Mo.

7. A wear-resistant titanium alloy orthopedic device, wherein said device has a core hardness of at least 28 HRC and a substantially increased near surface hardness at least 0.0005 inches beneath a surface of the device.

8. The device according to claim 7, wherein said near surface hardness is at least 50 HRC.

9. The device according to claim 7, wherein said near surface hardness is increased at least 0.0065 inches beneath the surface.

10. The device according to claim 7, wherein said device decreases in hardness from the surface to the core.

11. The device according to claim 7, wherein said titanium alloy is formed of titanium and a metal selected from the group consisting essentially of niobium, tin, zirconium, chromium, aluminum, molybdenum, vanadium, tantalum, silicon, and iron.

12. The device according to claim 11, wherein said titanium alloy is selected from the group consisting essentially of Ti-6Al-4V, Ti-13Nb-13Zr, Ti-12Mo-6Zr-2Fe, Ti-5Al-2.5Fe, Ti-3Al-2.5V, Ti-3Al-8V-6Cr-4Mo-4Zr, Ti-15Mo-3Al-2.7Nb-0.25Si, Ti-15Mo-2.8Nb-0.2Si, Ti-6Al-4V ELI, Ti-6Al-7Nb, Ti-35Nb-7Zr-5Ta, Ti-45Nb, Ti-8V-5Fe-1Al, Ti-15Mo-5Zr, Ti-11.5Mo-6Zr-4.5Sn, Ti-5Al-2Sn-4Zr-4Mo-2Cr-1Fe, and Ti-15Mo.

13. The device according to claim 7, wherein said orthopedic device is selected from the group consisting essentially of orthopedic implants, inner ear

implants, dental implants and cardiovascular implants.

14. The device according to claim 13, wherein said orthopedic implants are selected from the group consisting essentially of spinal implants, hip implants, knee implants, shoulder, elbow, finger, toe, other joint implants, bone plates, fixation screws, intramedullary nails, compression hip screws, pelvic plates, and other orthopedic implants.

15. A wear-resistant titanium alloy spinal implant.

16. The device according to claim 15, wherein said titanium alloy is formed of titanium and a metal selected from the group consisting essentially of niobium, tin, zirconium, chromium, aluminum, molybdenum, vanadium, tantalum, silicon, and iron.

17. The device according to claim 16, wherein said titanium alloy is selected from the group consisting essentially of Ti-6Al-4V, Ti-13Nb-13Zr, Ti-12Mo-6Zr-2Fe, Ti-5Al-2.5Fe, Ti-3Al-2.5V, Ti-3Al-8V-6Cr-4Mo-4Zr, Ti-15Mo-3Al-2.7Nb-0.25Si, Ti-15Mo-2.8Nb-0.2Si, Ti-6Al-4V ELI, Ti-6Al-7Nb, Ti-35Nb-7Zr-5Ta, Ti-45Nb, Ti-8V-5Fe-1Al, Ti-15Mo-5Zr Ti-11.5Mo-6Zr-4.5Sn, Ti-5Al-2Sn-4Zr-4Mo-2Cr-1Fe, and Ti-15Mo.

18. A wear-resistant titanium alloy orthopedic device.

19. The device according to claim 18, wherein said titanium alloy is formed of titanium and a metal selected from the group consisting essentially of niobium, tin, zirconium, chromium, aluminum, molybdenum, vanadium, tantalum, silicon, and iron.

20. The device according to claim 19, wherein said titanium alloy is

selected from the group consisting essentially of Ti-6Al-4V, Ti-13Nb-13Zr, Ti-12Mo-6Zr-2Fe, Ti-5Al-2.5Fe, Ti-3Al-2.5V, Ti-3Al-8V-6Cr-4Mo-4Zr, Ti-15Mo-3Al-2.7Nb-0.25Si, Ti-15Mo-2.8Nb-0.2Si, Ti-6Al-4V ELI, Ti-6Al-7Nb, Ti-35Nb-7Zr-5Ta, Ti-45Nb, Ti-8V-5Fe-1Al, Ti-15Mo-5Zr, Ti-11.5Mo-6Zr-4.5Sn, Ti-5Al-2Sn-4Zr-4Mo-2Cr-1Fe, and Ti-15Mo.

21. The device according to claim 18, wherein said orthopedic device is selected from the group consisting essentially of orthopedic implants, inner ear implants, dental implants and cardiovascular implants.

22. The device according to claim 21, wherein said orthopedic implants are selected from the group consisting essentially of spinal implants, hip implants, knee implants, shoulder, elbow, finger, toe, other joint implants, bone plates, fixation screws, intramedullary nails, compression hip screws, pelvic plates, and other orthopedic implants.

23. A method of forming a wear-resistant titanium alloy orthopedic device by deeply diffusing oxygen into the titanium alloy device.

24. The method according to claim 23, wherein said diffusing step includes heating the titanium device in the presence of an oxygen containing substance, thereby deeply diffusing oxygen into the titanium device.

25. The method according to claim 24, wherein said heating step includes heating the titanium device to a temperature of at least 800°F.

26. The method according to claim 24, wherein said diffusing step includes heating the titanium device in a substance selected from the group consisting essentially of air, carbon dioxide, carbon monoxide, oxygen, ozone, and nitrous oxide.

27. A method of hardening a device formed of titanium by deeply diffusing oxygen into the titanium alloy device.

28. The method according to claim 27, wherein said diffusing step includes heating the titanium device in the presence of an oxygen containing substance, thereby deeply diffusing oxygen into the titanium device.

29. The method according to claim 28, wherein said heating step includes heating the titanium device to a temperature of at least 800°F.

30. The method according to claim 27, wherein said diffusing step includes heating the titanium device in a substance selected from the group consisting essentially of air, carbon dioxide, carbon monoxide, oxygen, ozone, and nitrous oxide.

31. A method of enhancing wear properties of titanium alloy devices by deeply diffusing oxygen into the titanium alloy device.

32. The method according to claim 31, wherein said diffusing step includes heating the titanium device in the presence of an oxygen containing substance, thereby deeply diffusing oxygen into the titanium device.

33. The method according to claim 32, wherein said heating step includes heating the titanium device to a temperature of at least 800°F.

34. The method according to claim 31, wherein said diffusing step includes heating the titanium device in a substance selected from the group consisting essentially of air, carbon dioxide, carbon monoxide, oxygen, ozone, and nitrous oxide.